Prepared Statement of
W. David Montgomery, Ph.D.
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"The Role of Science in the Asia-Pacific Partnership"
Committee on Commerce, Science and Transportation
Subcommittee on Global Climate Change and Impacts
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Mr. Chairman and Members of the Subcommittee:

Thank you for your invitation to testify in today's hearing. I am David Montgomery, and I am Vice President of CRA International, where I am co-leader of its global Energy and Environment Practice. This testimony is a statement of my own research and opinions, and does not represent a position of CRA International.

I am particularly pleased by this opportunity to testify on "The Role of Science in the Asia-Pacific Partnership." I believe, based on studies that I and others have conducted over the past few years, that the Asia-Pacific Partnership offers an opportunity to define an approach to climate change policy that can reconcile the objectives of economic growth and environmental improvement for developing countries.

This testimony is organized in three parts. The first section discusses the opportunities that exist for cost-effective emission reductions in developing countries, and the role of technology transfer and foreign direct investment in taking up these opportunities. The second part of my testimony provides the reasons why these opportunities exist and discusses why it is critically important that policy be designed, as the Asia-Pacific Partnership is, to attack the root causes of both poverty and high CO2 emissions in developing countries. Those root causes are to be found in economic institutions that prevent sustained economic growth and cause wasteful energy use. Fundamental reform of economic institutions is required before any attempts to reduce the greenhouse gas intensity of developing economies can succeed, and that reform can be expected on its own to stimulate greater foreign investment and technology transfer. The final section of my testimony discusses how the Asia Pacific Partnership can realize these key opportunities and suggestions on possible ways in which the Partnership could be made more effective.

My overall conclusion is that the Asia-Pacific Partnership presents an opportunity to define a significant new international approach to climate policy, one that does not require emission caps or trading to achieve reductions in global emissions. Although

other countries are not willing to admit the failure of the Kyoto Protocol publicly, there are very promising signs of interest in the ideas embodied in the Asia-Pacific Partnership: the use of technology, the role of developing countries, and discussions among "large emitters." I therefore believe that this is a time when the United States can be engaged in international cooperation that moves away from the cap and trade approach embodied in the Kyoto Protocol toward a more technology and growth oriented approach to the climate problem. The Asia-Pacific Partnership provides the foundation for that approach.

I. Opportunity

I will make three points in regard to the opportunities that exist in developing countries.

1. Globally, the best opportunities for near-term, cost-effective reductions in greenhouse gas emissions are in China, India, and other developing countries
2. Developing countries are only interested in approaches to reducing their greenhouse gas emissions that will enhance opportunities for economic growth
3. Policies that stimulate greater technology transfer and investment in developing countries have the potential to achieve both economic growth and climate policy goals.

Greenhouse gas emissions are driven by population, income and technology. This fundamental relationship is described in an equation known as the "Kaya Identity."[2] It states that

$$Population * \frac{Income(\$)}{Population} * \frac{CO_2}{Income(\$)} = CO_2$$

The first two terms of this equation show that growth in total income comes from population growth and growth in per capita income. Technology appears in this equation in the third term, which describes CO_2 per dollar of income. The legitimate aspiration of poor countries is to keep per capita income increasing. Population is a separate and divisive issue– and in any event is not likely to be responsive to policies in the short run. Since per capita income growth and population growth are off the table, this leaves technology – CO_2/($) -- as the feasible object for change.

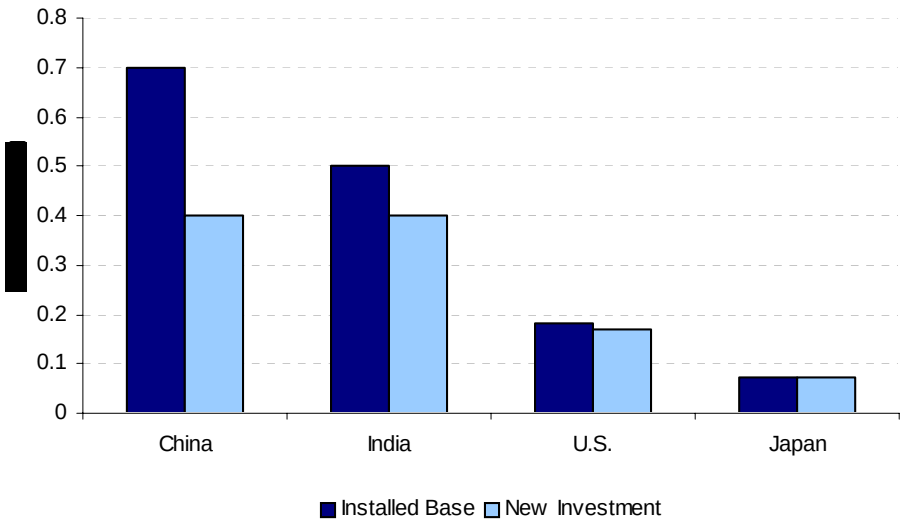
Technology is critically important because emissions per dollar of income are far larger in developing countries than in the United States or other industrial countries. This is both a challenge and an opportunity. It is a challenge because it is the high emissions intensity – and relatively slow or non-existent improvement in emissions intensity – that is behind the high rate of growth in developing country emissions.

[2] Y. Kaya, "Impact of Carbon Dioxide Emission Control on GNP Growth: Interpretation of Proposed Scenarios." Paper presented to the IPCC Energy and Industry Subgroup, Response Strategies Working Group, Paris, 1990.

Opportunities exist because the technology of energy use in developing countries embodies far higher emissions per dollar of output than does technology used in the United States; this is true of new investment in countries like China and India as well as their installed base (See Figure 1). The technology embodied in the installed base of capital equipment in China produces emissions at about 4 times the rate of technology in use in the United States. China's emissions intensity is improving rapidly, but even so its new investment embodies technology with twice the emissions intensity of new investment in the United States. India is making almost no improvement in its emissions intensity, with the installed base and new investment having very similar emissions intensity. India's new investment also embodies technology with twice the emissions intensity of new investment in the United States.

The United States is a good benchmark of technology that is economic at today's energy prices, without any additional incentives or regulations that would lead to adoption of more costly technologies for the purpose of reducing greenhouse gas emissions. Japan's emissions intensity is about half that of the United States, so that Japanese technology provides a benchmark for more aggressive efforts to reduce energy use.

Figure 1: Greenhouse Gas Emissions Associated with Existing and New Investment (Million tons C per $Billion GDP)



Priorities for Economic Growth

Developing countries have made it clear that their highest priorities are dealing with poverty, disease, famine, unemployment and violent conflict,[3] and that sustained economic growth is a prerequisite for dealing with these problems. Therefore, developing countries have also made it clear that they will not accept caps on their greenhouse emissions and have no interest in becoming part of a global emission trading

[3] The World Summit on Sustainable Development (WSSD) reaffirms the need to have balanced economic development, social development and environmental protection. It also reaffirms poverty eradication and preservation of the environment as the overarching objectives of sustainable development (United Nations 2002).

system—at least on terms acceptable to the industrial countries. They see these approaches to climate change policy as threatening their ability to grow and deal with their more pressing problems. Therefore, only approaches to climate policy that combine greater economic growth with reductions in emissions intensity have any chance of attracting the interest of developing countries.

The Importance of Technology Transfer

Technologies that offer lower CO_2 intensity have largely been developed in the industrial countries. Therefore technology transfer, which occurs largely through foreign direct investment, is required to replace carbon-intensive technology.

Technology transfer and increased investment have the potential for achieving large reductions in emissions. The potential from bringing the emissions intensity of developing countries up to that currently associated with new investment in the United States is comparable to what could be achieved by the Kyoto Protocol (See Table 1). These are near term opportunities, from changing the nature of current investment and accelerating replacement of the existing capital stock. Moreover, if achieved through transfer of economic technologies it is very likely that these emission reductions will be accompanied by economic benefits for the countries involved.

Table 1: Greenhouse Gas Emission Reductions Achievable Through Technology Transfer and Increased Investment

	To 2012 (MMTCE)	**To 2017 (MMTCE)**
Adopt US technology for new investment in China and India	**2600**	**5200**
Adopt US technology with accelerated replacement in China and India	**4200**	**7700**
Adopt continuously improving technology with accelerated replacement in China and India	**5000**	**9800**
EU under Kyoto Protocol (without hot air)	***600***	***1400***
All Annex B countries under Kyoto Protocol (including US and hot air)	***2800***	***7300***

The potential emission reductions estimated in Table 1 are derived from a study my colleagues and I performed using a model of economic growth based on the idea of "embodied technical progress." In the first case, we assumed that in 2005 new investment in China and India immediately moves to the level of technology observed in the United States, and calculate the resulting reduction in cumulative carbon emissions through 2012 and 2017. This is the technology transfer case. In the second case, we assume that policies to stimulate foreign direct investment accelerate the replacement of the oldest capital with new equipment, giving even larger savings. In the third case, we

assume that the new technology continues to improve over time, as it will if policies to stimulate R&D into less emissions-intensive technologies are also put in place. It can be seen that even the least aggressive of these policies has potential for emissions reductions as large as possible if all countries (including the U.S.) achieved exactly the emission reductions required to meet their Kyoto Protocol targets. This is because the technology gap is so large, and because of the large share of global emissions that will come from China and India in the next few decades.

It is also important to note that given the large difference between emission intensities of China and India and the U.S., and the relatively small remaining distance between the U.S. and Japan, most of the emission reductions achievable through technology transfer can be achieved be moving from current to U.S. technology. Going beyond this in the next decade or so, by pushing developing countries to adopt technology not currently economic even in the United States, entails rapidly increasing costs and smaller emission reductions.[4]

The difference in technology that accounts for the difference in emissions intensity between developing countries and the U.S. will not be eliminated without substantially greater technology transfer. That technology transfer occurs largely through the mechanism of foreign direct investment, as multinational companies bring with them the technology they have developed and use in their current markets. The combination of technology transfer and FDI is one of the strongest engines of growth. But increasing technology transfer and FDI to China and India requires removing current defects in their investment climate.

II. Causes of High Carbon Intensity and Effective Remedies[5]

In a highly developed economy such as the United States, characterized by efficient markets, pricing relatively undistorted by government policies or government-owned enterprises, free trade and free flows of capital, and strong legal institutions and protection of property rights, it is likely that there are few opportunities to improve carbon intensity without causing reductions in economic performance and income per capita. If technologies offering such opportunities exist, market forces and individual economic interest will lead to their adoption. This is not the case in many developing countries, which have economic systems characterized by a lack of incentives for efficient energy use, due to institutional and market failures, and an investment climate

[4] The potential for emissions reduction through technology transfer is discussed in P. Bernstein, W. David Montgomery and S. D. Tuladhar, "Potential for Reducing Carbon Emissions from Non-Annex B Countries through Changes in Technology." Accepted for publication, *Energy Economics*. 2006.
[5] This section is based on W. David Montgomery and Roger Bate. "Beyond Kyoto: Real Solutions to Greenhouse Emissions from Developing Countries." *AEI Environmental Policy Outlook*, July 1, 2004.
[7] *Economic Freedom of the World (EFW)* index is published by The Frasier Institute (http://www.freetheworld.com/release.html) and measures the degree to which a country is supportive of economic freedom. The EFW summary index is constructed from five different policy areas: (i) size of government; (ii) legal structure and protection of property rights; (iii) access to sound money; (iv) international exchange; and (v) regulation. *Index of Economic Freedom* is published by the Heritage Foundation/Wall Street Journal (http://www.heritage.org/research/features/index/) and reports 10 broad measures of economic freedom for 161 countries.

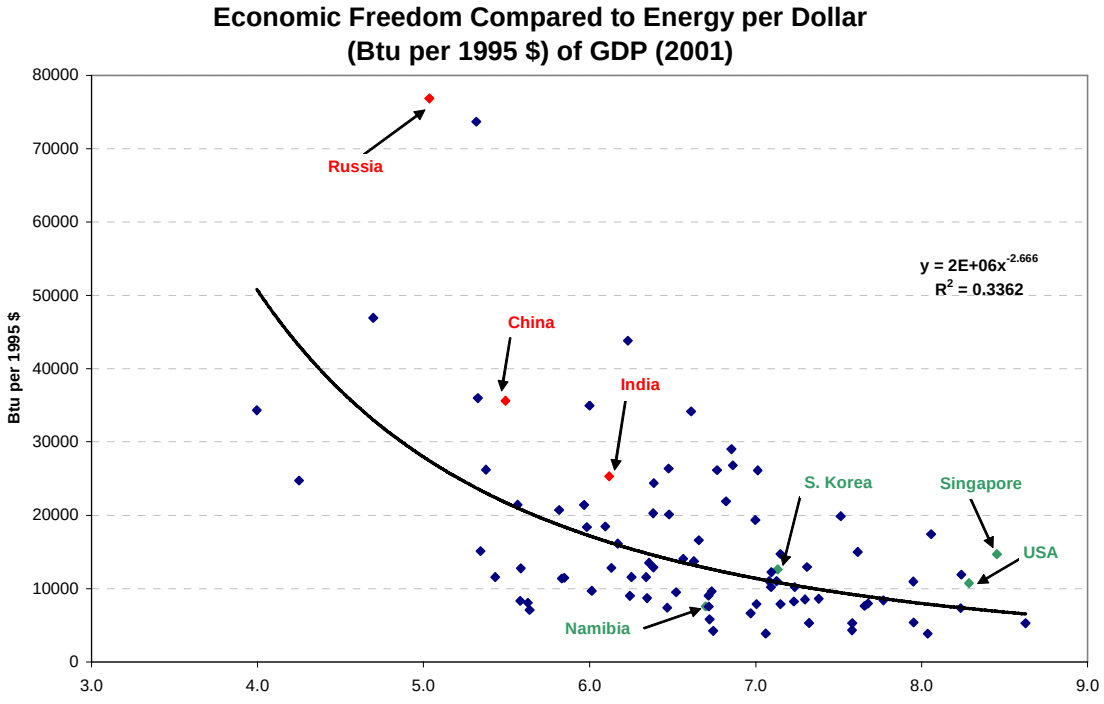
that discourages foreign investment and technology transfer. Remedying these institutional and market failures offers the prospect of reconciling economic growth and emissions reduction.

Economic Freedom and Emissions Intensity

The modern literature on economic development emphasizes the role of legal, market and governmental institutions in economic development. The concept of "economic freedom" summarizes a wide variety of conditions that are found to be conducive to individual initiative and economic growth.[7] Indices of economic freedom are based on comprehensive surveys of conditions around the world. The broad indices of economic freedom include specific institutional problems that can lead to high carbon intensity:

- Pricing systems that make efficient technologies unprofitable
- Institutions and policies that make markets inhospitable to foreign investment with world class technology
  - Rule of law and protection of intellectual property
  - Role of state owned enterprises
  - Access to foreign capital
- Lack of infrastructure, education and skills required for technology

Figure 2: Association Between Economic Freedom and Energy Intensity



Sources: Frasier Institute, Economic Freedom of the World, 2003,
U.S. Energy Information Administration, International Energy Annual, 2002

Lack of these components of economic freedom is clearly associated with high levels of energy use per dollar of GDP. Figure 2 plots scores on the Economic Freedom of the World Index compiled by the Frasier Institute against energy use per dollar of GDP, measured at market exchange rates.

Energy intensity is used as a measure because it is directly connected to greenhouse gas emissions from energy use. For example, three of the countries with the relatively poor scores on economic freedom, Russia, China and India, have high energy use and carbon emissions per dollar of GDP. At the other end of the scale, countries like South Korea, Singapore and Namibia with relatively free economies have much lower carbon intensities, similar to that of the United States.

The curved line represents the results of a statistical analysis of the association, which shows that about one-third of the variation in energy intensity is explained by differences in scores on economic freedom. This is an unusually clear relationship for this type of cross-sectional data. The literature on economic development also shows that the economic freedom index is very closely associated with per capita income and rates of economic growth.

In more recent, unpublished work my colleagues and I have focused on specific aspects of the institutional setting that can be expected to have a direct effect on either the efficiency of energy use or the transfer of economic technologies. This research reveals that both China and India have significant institutional shortcomings in such areas as the rule of law and administration of justice, protection of intellectual property, excessive bureaucracy and corruption, a dominant role of state enterprises in the economy, and inadequate infrastructure. In both countries, continued economic reform is recognized as being necessary to sustain current rates of economic growth. We have also found that the same institutional problems are directly connected to wasteful energy use, by diminishing or eliminating incentives for efficient use of resources, and discourage foreign direct investment of the type that leads to effective technology transfer.

Design of Policies that Can Be Effective and Engage Developing Countries

The evidence that high emissions intensity is closely associated with fundamental market and institutional failures leads me to conclude that the highest priority of the Asia-Pacific Partnership should be to facilitate the process of removing market and institutional failures in China and India.

Without remedies for the fundamental institutional problems that underlie poor scores for economic freedom, the continuation of two unfortunate current conditions can be expected:

- A hostile economic environment in China and India will prevent technology that is introduced through projects that the Partnership might support from spreading throughout the economy

- Emission caps will remain costly, because without new technology, emission reductions will require diverting resources that could otherwise be used for growth

If remedies are found for fundamental institutional problems, two kinds of results can be expected:

- Projects that transfer economic technologies will take place without further incentives and will lead to spillover effects and significant emission reductions

- The root causes of both poverty and high carbon intensity will be addressed together

The actions required to create fundamental institutional reform must take place within the developing countries themselves, and be designed and carried out by their governments, businesses and citizens. The Asia-Pacific Partnership includes China and India, the two developing countries with the largest current and potential future emissions; Korea, an Asia country whose success proves that economic freedom leads to growth and lower greenhouse gas emissions; and three countries that can be the source of direct investment and technology transfer -- Australia, Japan and the United States. The great opportunity afforded by the Asia-Pacific Partnership is to create a process in which all these countries can work together to identify the needs for institutional reform in China and India, understand the benefits that institutional reform would provide in enhancing economic growth and reducing greenhouse gas emissions, and take on appropriate responsibilities for bringing about those changes. But to do this, the Asia-Pacific Partnership must make institutional reform, not identification of specific projects to be funded by donor governments, its highest priority.

III. How the Asia-Pacific Partnership Can Support Institutional Reform

The Partnership starts with a tremendous advantage when it addresses institutional reforms that will facilitate technology transfer and reduced greenhouse gas emissions, because addressing institutional issues is critical to the highest priority of both China and India. Moreover, both countries have already begun the process of institutional reform, and recognize that their current rates of economic growth were made possible by those reforms.

In the first part of this testimony I have attempted to establish that institutional reform should be the highest priority of the Asia Pacific Partnership. This conclusion is supported first by evidence of a large gap in energy technology between China and India, on one hand, and the rest of the Partnership. This evidence comes from data on national and, to a limited extent, sectoral energy intensities which support inferences about the level of technology embodied in new investment. I also drew on research on institutional obstacles to economic growth to discuss areas in which China and India lack

a market oriented investment climate and other institutions that support efficient markets, and described how these deficiencies are likely to be causes of the technology gap.

This analysis provides strong indications that China and India lag far behind the US, Japan and Australia in technology, even in new investment, and that this lag and resulting high levels of greenhouse gas emissions are attributable to failings in legal, political and market institutions. There is also strong evidence that remedies for these failings would contribute to economic growth. However, much more detailed understanding of the opportunities for institutional reform and improved technology is required as a basis for an action plan, and a consensus on such an understanding is required to reach agreement on actual steps to be taken by members of the Partnership.

I believe that this consensus and agreement could be reached if the Partnership undertook four steps, that I arrange into two distinct phases.

The first phase would be a research and consensus building process, to provide a shared understanding of technological possibilities and institutional barriers. The first step in the research and consensus phase should be to identify and characterize the investment climate of China and India and the potential for emission reductions through transfer of technologies that would be economic but for institutional failures. This process would take place in working groups with participation limited to disinterested experts, representatives of the business communities and the APP governments. Achieving consensus across stakeholders and countries on the basic facts about the current investment climate and the role of FDI in promoting technology transfer will go a long way toward developing support for reforms.

It is critical that businesses who have had direct experience in applying state-of-the-art technology and dealing with the institutional setting in China and India tell their stories as part of this process. The key to success is not an outstanding set of studies by the experts, but identification of real world opportunities and barriers. Private sector knowledge of technologies that can make it on their own in the global marketplace and experience with institutional obstacles to doing profitable business in China and India is the essential foundation of this approach.

The second step would be for the same working groups to develop proposals, given the benchmarking exercise of the first step, that would accomplish significant changes. These proposals should describe specific institutional reforms that would have direct benefits for technology transfer and efficient use of energy. Proposals should include actions by all parties, so that they are broadly perceived as equitable and cooperative. In this step in particular, opinions of international businesses on how much change is needed to create a receptive investment climate should be taken as a major input.

The third step would move from working groups to interaction among the APP governments to understand the difficulties associated with removal of obstacles for technology transfer in particular and institutional reform in general, and what each government could contribute. The current institutional climate in China and India exists for a reason, and how incremental reform can proceed in the face of interests that benefit

from the status quo must be addressed directly. The interaction should identify actions that China and India would be willing to see Australia, Japan and the United States undertake to encourage, speed and reward the process of institutional reform, as well as feasible actions to be undertaken in China and India by their respective governments.

The final phase should be to create an ongoing process in which Partnership governments would agree to concrete actions that each would take to support institutional reforms and achieve the identified benefits for climate and economic growth. This should be designed as a pledge and review process, in which each government agrees to undertake actions desired by the others and periodically to review whether commitments were carried out. Such agreements tend to be self-enforcing, because any country that fails to abide by a commitment faces the credible consequence of losing future benefits.

Finally, I would suggest that the hardest thing in thinking about policies addressing global poverty, oppression and environmental progress is to avoid making the best the enemy of the good. Technology is a critical issue because there is no economic possibility of stabilizing greenhouse gas concentrations without R&D to create technology not available today. [15] In the long term, this technology is required to turn around developing country emissions, just as it is required to turn around emissions from the industrial world. In the long run, new technology for developing countries is clearly critical. R&D to create this technology is therefore also critical, and the technology that is economically successful may be different in the global South than in the global North.

But right now the huge opportunity is in replacing technology now being used in the global South with technology now being used in the global North. Therefore, it is extremely important to keep the focus of the Asia-Pacific Partnership on bringing about the critical market reforms that will lead to greater technology transfer and improvements in carbon intensity. Identification of deficiencies in institutions and economic freedom in each country should be a key first step, after which the members of the Partnership can address mutually supportive actions to remove those barriers and improve the flow of investment and technology into China and India.

[15] M. I. Hoffert *et al*., "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet" *Science*, Vol. 298, Nov.1, 2002, p. 981-7.